Sveriges lantbruksuniversitet
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Herd biosecurity in smallholder settings

With focus of African swine fever in Uganda

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Herd biosecurity in smallholder settings – with focus on African swine fever in Uganda

Biosäkerhet på besättningsnivå i småskalig djurproduktion – med fokus på afrikansk svinpest i Uganda

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SUMMARY

The objectives of this study was to investigate smallholder farmers' behaviour and perceptions on biosecurity and to describe a recent outbreak of African swine fever (ASF) on a farm in an ASF endemic setting, with focus on biosecurity aspects.

Biosecurity is a prerequisite for successful pig production but many smallholder farmers lack the ability to implement such measures, for several reasons, making their animals more prone to acquire infectious diseases.

ASF is a viral disease, affecting pigs with high morbidity and mortality. The disease has a complex epidemiology with a sylvatic cycle as well as a domestic cycle, thus in endemic countries there are many routes of transmission.

This study found that smallholder pig farmers had confidence that biosecurity could protect their pigs, but smallholders that recently lost pigs in ASF had a lower confidence in biosecurity. The tendency to invest in biosecurity equipment was higher in households with an additional source of income compared to households with crop farming income only.
The recent ASF outbreak and the investigation that followed, showed that despite high ambitions and investments, ASF was introduced to the herd with severe consequences, wiping out all animals in the course of three months. In the ASF endemic setting of the farm, several possible ways of introduction were identified as well as actions performed during the outbreak that enabled the disease to be spread throughout the farm.

SAMMANFATTNING

Målen med studien var att undersöka beteenden och uppfattningar om biosäkerhet hos småskaliga djurproducenter samt att beskriva ett nyligt utbrott av afrikansk svinpest (ASF) i en besättning belägen i ett ASF-endemiskt område, med fokus på biosäkerhetsaspekter.

Biosäkerhet är en grundförutsättning för framgångsrik djurproduktion, men många småskaliga djurhållare saknar av flera skäl möjligheten att implementera sådana åtgärder, med konsekvensen att deras djur löper högre risk att drabbas av infektiösa sjukdomar.

ASF är en viral sjukdom hos grisar med hög mortalitet och morbiditet. Sjukdomens epidemiologi är komplex med bland annat en sylvatisk cykel och en cykel bland tamgrisar med följden att det finns många möjliga smittvägar i endemiska länder.

Denna studie fann att småskaliga grishållare hade tilltro att biosäkerhet kunde skydda deras grisar, men att de grishållare som nyligen förlorat grisar i ASF hade ett generellt lägre förtroende för biosäkerhet. Tendensen att investera i biosäkerhetsutrustning var högre i hushåll med ytterligare inkomstkällor än hos de hushåll som försörjde sig genom endast sitt jordbruk.
Det nyliga utbrottet av ASF och den utredning som vidtogs visade att trots den höga ambitionen och investeringen kunde ASF introduceras i besättningen med allvarliga konsekvenser, samtliga grisar var döda inom tre månader. I den ASF-endemiska omgivningen kunde flertalet möjliga källor till introduktion identifieras liksom handlingar som ledde till att sjukdomen kunde spridas i hela besättningen.

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INTRODUCTION

This study was performed as a Minor field study (MFS) and was part of a Sida-financed research project in Uganda performed in collaboration between the Swedish University of Agricultural Sciences (SLU), the National Veterinary Institute (SVA), Makerere University, Kampala, Uganda and International Livestock Research Institute (ILRI).

The study consisted of two parts: 1) a household level interview study performed among smallholder pig farmers in Gulu District using a questionnaire and 2) a case-study of an African swine fever outbreak in a larger pig farm in Lira District.

African swine fever (ASF), a haemorrhagic pig disease with high mortality, is endemic in Uganda. Domestic pigs develop symptoms while wild African suids such as warthogs and bushpigs are asymptomatic carriers of the virus. Soft ticks of the *Ornithodoros* spp are the natural reservoirs of the virus in Africa and may act as vectors (Costard *et al*., 2009b).

Uganda is a landlocked country in East Africa. A vast majority of the population live in rural areas and poverty is more widespread in these areas compared with urban areas (World Bank, 2014). For smallholders in Uganda, the keeping of pigs provide an extra income as well as a complement of protein in people's diets. ASF constitutes a potent threat to pig production as the disease's morbidity and mortality is very high (Kabuuka *et al*., 2014).

Biosecurity can be defined as the preventive measures taken to protect animals from infectious diseases. This includes prevention of transmitting infections within and between farms (Fasina *et al*., 2012a). By preventing animal diseases, financial and social losses for people keeping livestock can be reduced. Implementation of biosecurity measures is also of importance for animal welfare as animal diseases can be a negative effect on animal welfare.

The objective of this study was to investigate the behaviour and perceptions of smallholder farmers focusing on biosecurity and to describe a recent ASF-outbreak on a larger farm, with the aim to identify relevant biosecurity factors.

LITERATURE REVIEW

Control measures to prevent animal diseases in smallholder farms

For the prevention of animal diseases, biosecurity is fundamental (Penrith & Vosloo, 2009). Conan *et al*. (2012) describe that biosecurity is not standardized, and it is therefore required to adapt biosecurity measures according to disease.
Biosecurity in this context can be defined as measures implemented to prevent introduction of infectious diseases to, and spread within, the herd.
To enable successful pig production in ASF endemic countries, as well as elsewhere, biosecurity is considered a prerequisite (Fasina *et al*., 2012a).

When looking at on-farm biosecurity among pig farms in the Philippines, Alawneh *et al*. (2014) found that larger commercial and smallholder farms (mean number of animals 3102 and 22 respectively) had implemented adequate biosecurity measures to prevent disease introduction to their herds when compared to smaller commercial and smallholder farms (mean number of animals 481 and 9 respectively). Many of the smaller farms in the study had a farm layout with a market pen on the farm, enabling livestock traders with vehicles to come in close proximity to the animals, which is hazardous in terms of disease prevention (Alawneh *et al*., 2014).

A Laotian study on knowledge of smallholders on biosecurity with focus on Foot and mouth disease (FMD) and haemorrhagic septicaemia (HS) in large ruminants showed that the knowledge on health, disease and nutrition was limited (Nampanya *et al*., 2010). These findings are consistent with the results of a Nigerian study where inadequate understanding and implementation of biosecurity was reported among smallholder pig farmers. Risk behaviours practised by these smallholders were selling of survivor pigs, slaughtering ASF-infected animals within their pig premises and visiting other infected pig premises or slaughter slabs without any precaution (Fasina *et al*., 2012b).
On the other hand, Crafoord (2014) describes that smallholder farmers in Gulu district, Uganda, were able to identify parameters for successful pig farming. Parameters described were general cleanliness, reducing access for visitors, good housing etc, indicating an understanding for basic control measures.

Penrith & Vosloo (2009) have compiled the following examples of preventive measures for impeding infectious disease in animals; implementing disinfection of visitors to the animals by providing veterinarians or workers with protective clothes and disinfectant foot bath. Such protective clothing is not to leave the farm after it has been used. Another preventive measure is the ensuring that the number of visitors is kept at a minimum and not granting people or vehicles access to the area were animals are kept. Is is also concluded that disinfectant foot bath should not be seen as the only precaution, as it is not entirely effective (Penrith & Vosloo, 2009).

Smallholder farmers

Alawneh et al. (2014) describe smallholder pig farmers in the Philippines as keeping up to 41 pigs for household consumption and financial security. These smallholders experience a high level of exposure to infectious disease due to direct and indirect contact, for example mixing

of pigs and people or vehicles entering the area were pigs are kept. This type of animal husbandry makes disease prevention and control difficult (Alawneh et al., 2014).

In terms of disease control, it is crucial to ensure that smallholders participate in the implementation of control strategies, to achieve the objective of not enabling further transmission of disease. This is especially true in countries where ASF is endemic, like Uganda, where veterinary services often are unable to ensure compliance with regulations, due to lacking resources (Costard et al., 2009b).

Smallholder awareness regarding animal diseases has been described as lacking (Costard et al., 2009b; Nampanya et al., 2010). But when it comes to ASF in Uganda, Chenais et al. (2015) describe that many smallholders are aware of clinical signs, disease transmission as well as disease control. The results of Chenais et al. (2015) indicate that it is not lack of knowledge among smallholders that enables the virus to be transmitted, but it can be regarded as at least in part caused by inadequate management due to poverty.

As previously mentioned, a majority of Ugandans live in rural areas were poverty is widespread. Many smallholder farmers in these rural areas lack access to vehicles or roads, which obstructs their access to markets. They are prevented from enjoying the benefits of technology and advances in optimizing production and in reducing disease (World Bank, 2014; Rural poverty portal, 2014). Crafoord (2014) describe that the reason that smallholders in Uganda kept pigs free range was due to lack of money and/or feeds. Another difficulty experienced by smallholder pig farmers is the low status of pig keeping in some cultures, which could further obstruct the implementation of preventive or control measures (Crafoord, 2014).

African swine fever

African swine fever (ASF) is an important pig disease, endemic in most sub-Saharan countries (Penrith *et al*., 2013). The disease is caused by African swine fever virus (ASFV), a large DNA-virus, and there is currently no vaccine available (Costard *et al*., 2009b). The lack of a vaccine makes the prevention of the disease focus solely on preventing contact between susceptible host animals and the virus (Penrith & Vosloo., 2009). In its original setting in Africa the virus is maintained in its wildlife hosts; wild suids and soft ticks of the *Ornithodoros* spp. Wild African pigs are asymptomatic carriers and only domestic pigs develop symptoms (Costard *et al*., 2009b).

Warthogs do not appear to spread the virus, neither horizontally nor vertically, but soft ticks that feed from warthogs can transmit the virus to other pigs. Warthog piglets are infected by soft ticks while still in the burrow, where the soft ticks reside, and subsequently get viraemia lasting two-three weeks. Once infected, the soft ticks of *Ornitodoros* spp. are able to retain the virus for a long time (Costard *et al*., 2009b).

ASFV in transmitted between domestic pigs via direct contact between animals, different forms of indirect contact such as contaminated objects (equipment, clothes, boots etc), via pigs consuming contaminated pork and through infected soft ticks. Infected pigs shed virus before showing any clinical signs as well as when clinical signs have developed (Penrith & Vosloo., 2009).

Another cycle of transmission exists between domestic pigs and soft ticks and a third cycle is constituted by transmission between domestic pigs only, without the involvement of the wild hosts (Penrith *et al*., 2013). In several endemic areas in Africa, the most important mean of transmission of the virus is between domestic pigs (Costard *et al*., 2009a; Costard *et al*., 2009b).

Impact of ASF

The consequences of ASF are severe for farmers, as well as for affected nations and for international trade. Poorer pig producers often lack the ability to implement basic biosecurity measures which make their animals more prone to acquiring infectious diseases. Diseases such as ASF constitutes a threat to their herds and consequently their economy, as well as affecting the possibility of endemic countries to establish on external markets (Costard *et al*., 2009b; Fasina *et al*., 2012b). In addition to the strain ASF adds to the economy, the disease is also a potent threat to animal welfare and food security (Costard *et al*., 2009b).

Risk factors for ASF infection

Penrith *et al*. (2013) identified large pig populations with high contact rates as a risk factor for ASF. The constant source of naïve pigs to infect creates a situation where an outbreak can continue for a long period of time. The disorganisation of the pig sector in Africa and the risk it constitutes for transmitting ASF, is amplified by large pig populations (Penrith *et al*., 2013; Penrith & Vosloo, 2009).

Contact between domestic pigs and the sylvatic cycle or ASF-infected material are risk factors for ASF, and free range pigs are at a higher risk for being exposed to ASF (Penrith *et al*., 2013; Fasina *et al*., 2012a; Fasina *et al*., 2012b). Exposure can occur both through direct contact with infected animals and when domestic pigs scavenge on carcasses from pigs that died in ASF or on waste containing contaminated pork (Penrith & Vosloo, 2009). Free range pig movements and lacking biosecurity are other factors that facilitate domestic pigs being exposed to ASFV. Other examples are the mixing of animals at markets or during transport as well as slaughtering without proper waste management or cleaning (Costard *et al*., 2009b).

Keeping pigs confined, however, make them dependent on humans for water, feeds, hygiene and other aspects of well-being. Confined animals are still at risk of ASF or other infectious diseases if hygiene or biosecurity is inadequate. In Africa, affordable pig feed is uncommon, resulting in confined pigs being fed household or restaurant waste, which could contain contaminated pork products (Penrith *et al*., 2013).

Risk factors for ASF infection on farm level identified in a Nigerian study were keeping of pig herds that are not closed herds, and not to practice quarantine when buying new animals that are potentially infected or have been in contact with infected pigs. Service boars are also considered as potential risks of infection. Further factors associated with a high risk of contracting ASF were if an abattoir or infected pig farm was present in the area of pig farms (Fasina *et al*., 2012b).

A likely way of introduction of ASF is via infected pork products (Costard *et al*., 2009b). When ASF has been introduced to continents outside Africa, it is considered to be a result of

infected pork products (Costard *et al*., 2009b; Penrith *et al*., 2013). Movement of infected pigs and contaminated pork products is also what has caused the majority of recent outbreaks in Africa (Penrith & Vosloo, 2009).

Preventive measures for ASF

Lack of biosecurity is considered to be the main reason for the persistence of ASFV in the Nigerian pig population (Fasina *et al*., 2012a). To prevent ASF, strict biosecurity measures need to be established between the virus and its susceptible hosts. As the virus lacks the ability to be transmitted over large distances without human interference, biosecurity makes ASF-prevention possible (Penrith & Vosloo., 2009).

Possible preventive measures to stop spread of ASF in endemic areas could be to control local markets with live animals, discourage the keeping of free range pigs as well as farm visits by middlemen within the pig sector. These measures focus on the most important risk factors for transmission of the disease (Costard *et al*., 2009a; Costard *et al*., 2009b).

As introduction of ASF via pork is considered to be an important means of transmission in Africa as well as elsewhere (Costard *et al*., 2009b; Penrith & Vosloo, 2009; Penrith *et al*., 2013), prohibiting the feeding of leftovers or waste to pigs is a preventive measure of great importance (Penrith & Vosloo, 2009). However, when keeping in mind the economic situation of the smallholders and the absence of affordable pig feeds in these settings, feeding pigs leftovers is at least more advisable than feeding them waste, as the leftovers have been heat treated.
Preventive measures with the aim to prevent ASF, such as protective clothing, disinfectant foot bath, keeping the number of visitors to a minimum, would also, if fully understood and implemented, hinder the transmission of other diseases (Penrith & Vosloo., 2009).

Confinement of pigs reduce the losses experienced during outbreaks of ASF (Penrith *et al*., 2013). In low income countries like Uganda, pig husbandry systems as well as biosecurity could be improved to control the disease and its transmission (Sánchez-Vizcaíno *et al*., 2012).

FIELD STUDIES

Objectives

The objectives were:

- To investigate smallholder farmers' behaviour and perceptions regarding biosecurity
- To describe an outbreak of ASF on a larger farm, with focus on biosecurity aspects
- To gain knowledge about veterinary practice and research in a low-income country

MATERIAL AND METHODS

The study was performed during September-November 2014 and consisted of two parts: a household interview study targeting smallholder farmers (Study one) and one descriptive case-study of an ASF outbreak in a larger pig farm (Study two). The study was carried out in collaboration with Mikaela Klahr Fritz, a fellow veterinary student, with her study focusing on the socio-economic impact of animal diseases in smallholder settings.

Study one

Study area

Study one was performed in Gulu District of Northern Uganda. Gulu has a human population of approximately 444000 according to the 2014 census (Ubos, 2014). All 12 subcounties and a subdivision of Gulu municipality were included in the study.

The Gulu area has been severely affected by the civil war recently fought between government troops and rebels of the Lord's Resistance Army (LRA). Today, Gulu town is characterized by peace and tranquillity and the population, which has experienced a massive increase of almost 400% in 23 years, is now battling with poverty, high unemployment rates and a high HIV/AIDS prevalence compared to the rest of Uganda (Briggs, 2013; Accorsi *et al*., 2005; Ubos, 2014). In post-conflict Gulu, keeping of pigs and other livestock, is an important source of income as well as an important protein complement in the population's diets. Conventional saving of capital in banks is rare, and people tend to invest in livestock rather than putting money in the bank (personal communication, T.Aliro, DVO Gulu). This is a very vulnerable way of saving capital, as there are several infectious animal diseases which have the potency to wipe out animals, and consequently, people's savings. African swine fever is an example of such a disease.

Study design

Study one was a household interview study with 198 included households. These households were randomly selected from a sampling frame of 4000 pig keeping households from all 12 subcounties. The sampling frame used had been created previously using local informants (so called Community Knowledge Workers) and as part of previous research activities within the longterm project. All villages in the included parishes had been visited, and interviews with a maximum of 20 pig keeping households in each village had been conducted. One round of interviews had already been carried out in all the included households approximately six months earlier within the long-term project on ASF previously mentioned. At the previous visit, the households' GPS coordinates were noted, which also facilitated in locating the households for the current study.

Questionnaire

The questionnaire used was developed within the long-term project on ASF, and contained 70 questions of which the majority were closed, but some were open-ended. Several questions were designed so the respondent would answer with her/his level of agreement to different statements. The respondent was an adult representing the household, able to provide sufficient information regarding the household's pig keeping activities (e.g head of household or spouse/adult child to head of household). For this study not all questions of the questionnaire were included as it is used in whole in the previously mentioned research project. The interviews were held in the local language, Luo, by two different enumerators from the Gulu district veterinary office, and the duration of the interviews were between 30-60 minutes with few exceptions. The questions included in this study are shown in table 1.
For the complete questionnaire used for Study one please see appendix 1.

Data compiling and analysis

Data was recorded on paper-copies of the questionnaire. As soon as possible after each interview the data from the questionnaires was entered into EasyResearch, an internet-based tool provided by QuestBack (QuestBack International HQ, Oslo, Norway), whereupon the data could be processed in Microsoft Excel. The statistical analysis was later conducted in RStudio (Version 0.98.495 – © 2009-2013 RStudio, Inc., Boston, MA), with chi-square tests using the commands "*table"* and *"chisq.test".* Results were considered statistically significant if the p-value ≤ 0.05.

Study two

Study population

Adina Foundation is a Norwegian non-governmental organisation (NGO) with a branch of the foundation situated in the Ugandan city of Lira in northern Uganda. Adina Foundation in Lira is constituted by Lira Rehabilitation Centre (LRC) and Adina farm, a piggery established to economically support the LRC. LRC has the objective to rehabilitate children with disabilities and underprivileged children. The aim of Adina farm was to produce piglets and pork of top quality but also to offer training for small scale farmers in Lira District. Adina farm is not a typical example of a smallholder farm, but is included in the study as a valuable example of biosecurity and the challenges facing a pig farm situated in an ASF endemic setting.

The Foundation's vision is to have an agricultural training centre in place within the compound.

The breeding of the pigs started in midyear of 2013 and at the start of 2014 there were approximately 150 animals. The slaughter and sales of animals started in January-February of 2014 and the prognosis for the entire year was to sell 200 adult pigs in addition to a smaller number of piglets.

An outbreak of ASF occurred in the spring of 2014. At the beginning of the outbreak, pigs were sampled for ASF. ASFV was confirmed by PCR.

Study design

Study two was an in-depth interview study with pre-written questions and questions that came up during the interview. Answers were written down during the interview. Observations were also made during the visit to Adina farm.

Data compiling and analysis

Interviews with spokesperson and financial manager of Adina farm took place on two occasions. In addition to the interviews, data from the outbreak investigation conducted by Swedish and Ugandan veterinarians at the time of the outbreak was used. Further interviews were conducted with Michel Dione and Emily Ouma, ILRI, who had visited the farm and given advice after the outbreak. Information regarding biosecurity was extracted from the investigation data.

Table 1 *Questions from the questionnaire included in study one, investigating views on biosecurity in smallholder households in Gulu District from a household survey conducted between September-November 2014*

Questions number	**Question**
22.	Does the household have off-farm income?
23.	Is the household engaged in the following pig related activities; pig trading, processing of pork/pork products (e.g slaughter), operating a butchery, operating a pork kiosk, operating a pork joint, other?
24.	Indicate the type and number of livestock kept/owned currently
25.	Indicate the different categories of pigs kept currently
26.	Have any pigs left your herd since the last visit?
27.	Pig exits
29.	Has there been any inflow of pigs through purchases, births or any other form since the last visit?
30.	Pig entries
32.	Have you done any expansion in the pig enterprise since last visit?
33.	If yes, specify how
45.	Indicate the source of breeding for the sows since the last visit
48.	Did you have any hired labour engaged in the pig enterprise since the last visit?
50.	Did your pigs receive any medical treatments (deworming, antiparasitic, prophylaxis, antibiotics, vaccination) since the last visit?
51.	If yes, what treatment(s)?
53.	Did you have any expenditure for biosecurity equipment (protective clothing, boots, disinfectants etc) since the last visit?
54.	If yes, what sort of equipment did you buy?
55.	What was your total expenditure for biosecurity equipment since the last visit?
69.	How do you agree with the following statements;
	I think it is possible to protect my pigs from getting ASF by improving farm biosecurity
	I would like to invest in farm biosecurity if I received advice on what to do
	I would be happy to buy pork products from a slaughterhouse that receive pigs that have been in contact with pigs dying from ASF
	It is safe to give pigs water that has been used to clean knives and pangas use for slaughtering and butchering as drinking water
	Buying live pigs is a risk behaviour for contracting ASF
	ASF can not be prevented
	Improved farm biosecurity improves pig health and pig growth
	It is possible for me to tell visitors such as veterinarians, middle men

and extension workers not to enter the pig house with their own boots

RESULTS

Study one

Demographics

Out of the 198 smallholder households included in the study, 156 (79%) kept pigs at the time of the interviews. The total number of pigs kept by the households were at the time 663 distributed in categories of sows, boars, growers and piglets, with a mean value of 3.4 pigs per household (range 0-20 pigs). The majority of pigs were of local breed and the housing of pigs was categorised in free range, tethered and confined. Some households practised two different housing systems, see table 2.
The majority of households had crop farming as their only income and one third (31%) of the households had off-farm income.

The households had previously been visited within the long-term project and the last visit was approximately six months ago. For events that occurred since the last visit, see table 3.

Perceptions and attitudes towards biosecurity

Households that lost pigs due to ASF during the last six months agreed to a lesser extent that biosecurity would protect their pigs from getting ASF than households that had not been affected by ASF (p-value <0.01). See figure 1.

Table 2 *Distribution of pig housing practised by pig keeping households in Gulu District, in a survey conducted between September-November 2014*

Type of housing	**Number of households**	**Percentage of households**
Confined	32	21%
Tethered	35	22%
Free range	53	34%
Confined & tethered	4	3%
Confined & free range	8	5%
Tethered & free range	24	15%
Total	156	100%

The belief that ASF can not be prevented was more common among households that did not keep pigs confined only, compared to households that had pigs confined only, see figure 2. The 32 households that had pigs confined only were also more likely to agree that it was possible to protect pigs from contracting ASF by improving farm biosecurity. Three households from two different subcounties reported that their pigs had received vaccination against ASF.

Table 3 *Descriptive results showing smallholder households and events that had occurred since last visit approximately six months earlier, from a household survey conducted between September-November 2014*

Parameter	**Amount**	**Percentage of households**
Households keeping pigs	156	78.8%
Average number of pigs per household	3.4 (range 0-20)	
Average number of household members	7 (range 1-21)	
Number of households that lost pigs in ASF	15	7.5%
Number of households that sold pigs	130	65.6%
Number of households that lost pigs in any disease	53	26.7%
Number of households that have made expansion in the pig enterprise	23	14.7%

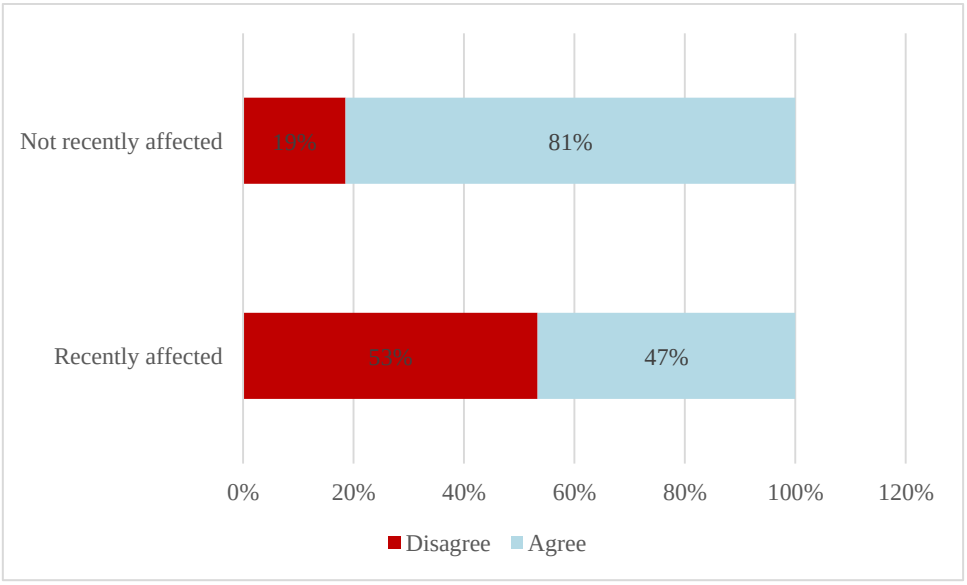


Figure 1 *Level of agreement to the statement "I think it is possible to protect my pigs by improving farm biosecurity" distributed between households recently affected by ASF and not recently affected by ASF, p-value<0.01.*

Households with confined pigs were also more likely (p-value<0.01) than other households to have done a recent expansion in the pig enterprise. Households without other pig engagement (pig trading, processing of pork/pork products, operating a butchery, operating a pork joint, operating a pork kiosk and other) were more likely (p-value<0.01) to agree with the statement that it is possible to protect pigs from getting ASF by improving farm biosecurity, than households that engaged in other pig activities.

Households recently affected by ASF were more willing (p-value=0.01) to buy pork products from a slaughterhouse that receive pigs which have been in contact with pigs dying from ASF compared to households not recently affected, see figure 3.

Expenditure for biosecurity

Households that were engaged in other pig engagements (pig trading, processing of pork/pork products, operating a butchery, operating a pork joint, operating a pork kiosk and other) were more likely to have had expenditure for biosecurity equipment than households with no other pig engagement (p-value <0.01). The 22 households that had had expenditure for biosecurity equipment since the last visit had invested in gumboots, gloves, spray pump and antiparasitic spraying of areas were pigs were kept. The mean value of expenditure for biosecurity equipment was for the 22 households approximately 19650 Ugandan shillings (equivalent to 7 USD) with the lowest and highest amount at 5000 and 95000 Ugandan shillings respectively.

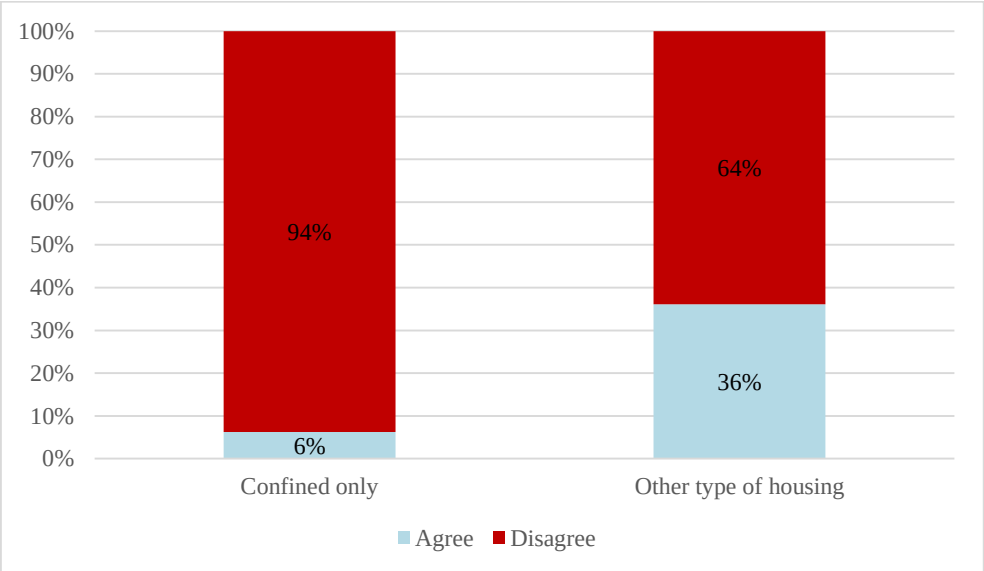


Figure 2 *Distribution of level of agreement to statement "ASF can not be prevented" compared between groups that keep pigs confined only (n=32) or tethered/free range or confined + other housing category (n=166). Answers have been labelled "Agree" for answers strongly agree, agree and neither agree nor disagree and "Disagree" for answers strongly disagree and disagree. The difference between the groups was significant, p-value<0.01.*

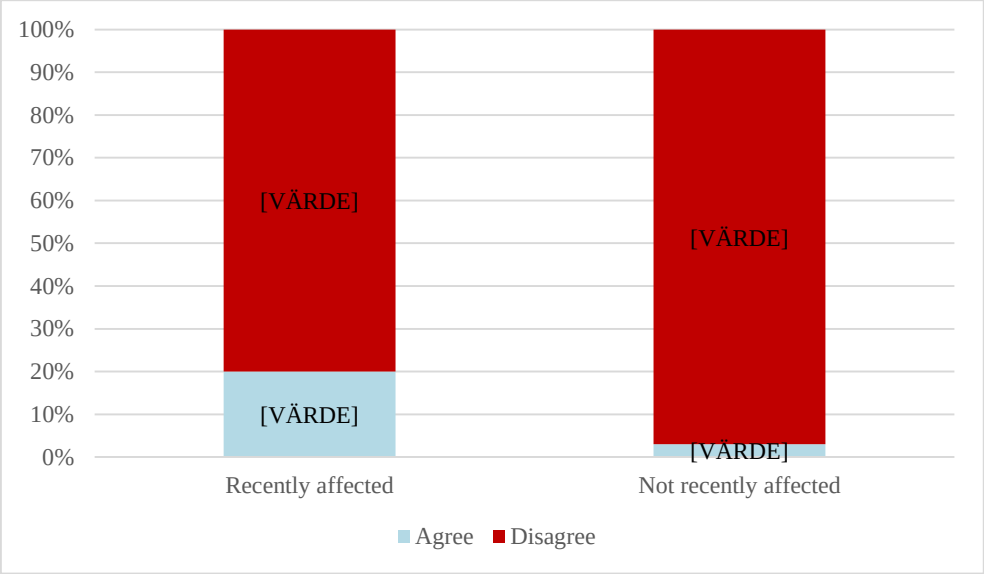


Figure 3 *Distribution of agreement to statement "I would be happy to buy pork products from a slaughterhouse that receive pigs that have been in contact with pigs dying from ASF" between households recently (n=15) and not recently affected (n=181) by ASF. Answers have been labelled "Agree" for answers agree and neither agree nor disagree and "Disagree" for answers disagree and strongly disagree. The difference between the groups was significant, p-value=0.01.*

Households with off-farm income were more likely to have bought biosecurity equipment than households that only had farm income, see table 4.

The willingness to invest in biosecurity after receiving advice did not differ significantly between households recently and not recently affected by ASF. The distribution of answers given from all households is shown in figure 4.

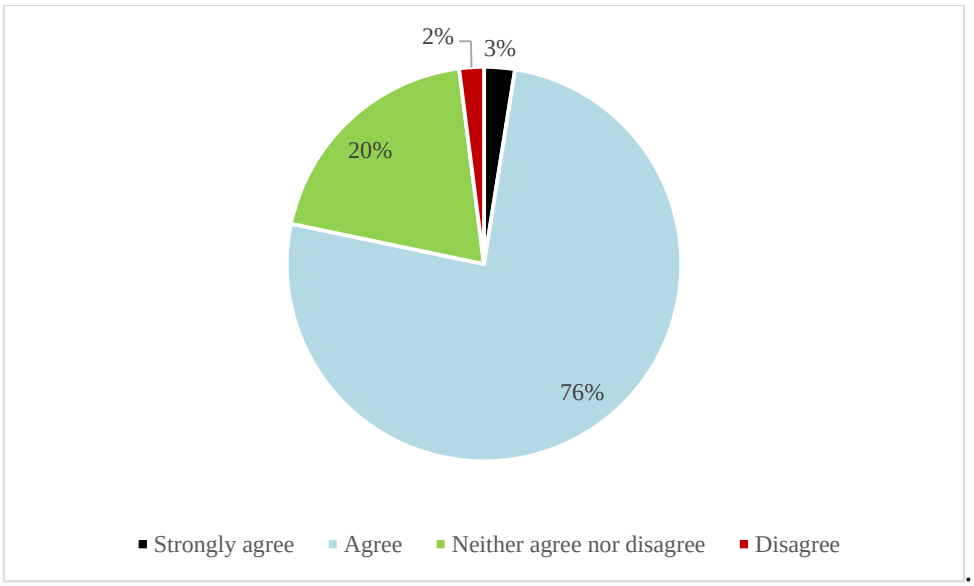


Figure 4 *Distribution of answers given from all households to statement "I would like to invest in farm biosecurity if I received advice on what to do", from a household survey conducted in Gulu district between September-November 2014.*

Table 4 *Distribution of households that had bought biosecurity equipment and had not bought biosecurity equipment, from a household survey in Gulu district conducted between September-November 2014. The difference between the groups was significant, p-value=0.02*

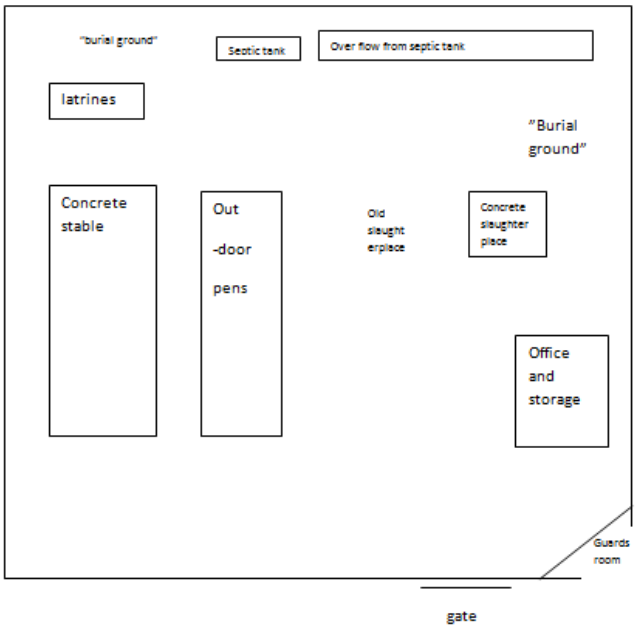
	Have bought biosecurity equipment	**Have not bought biosecurity equipment**
Off-farm income	12 (20%)	49 (80%)
No other income	10 (7%)	125 (93%)

Pig housing factors

Confinement of pigs was not correlated to losing pigs to ASF or other diseases (this included reasons for pig exit: death due to disease, sold because sick and slaughter because sick). Buying of live pigs was not statistical significant for consequently losing pigs to ASF. The different points of purchase (within village, neighbouring village or other) of pigs as well as the keeping of other livestock was not correlated to ASF or other disease.

Study two

Farm layout and routines



For a map of the compound, see figure 5.

Figure 5 *Sketched map of Adina farm compound in Lira, Uganda. (Illustration: Adina Foundation).*

Adina farm was fenced in with barbed wire, with a total area of approximately 40x60 m. The pigs were confined in a cement house with ten pens, five on each side of an aisle. Another three pens were situated outside, see figure 6. Outdoor pens had cement floor, wooden fence and a tin roof. A slaughter slab was situated within the compound.

The animals were recruited from profit farms and were fed commercial pig feed, a mixture of green feeds from local suppliers and vitamin supplements.

The pens were cleaned with a water hose and the water was led to a septic tank with a capacity of approximately $36m^3$. When cleaning the outside pens, cleaning water was flowing on the side of the construction towards the slaughter slab. The septic tank was overflowed at the time of the outbreak resulting in a stream of septic water which covered half of the length of the lower part of the fence, see figure 6.

The staff consisted of the farm manager, two guards and one farm worker. As both guards and the farm worker were hired as casual labour there had been a high turn-over of staff, with four members of staff having left in the six months before the outbreak. All members of staff were provided with gumboots and overalls. The routine for the gumboots was that they should be disinfected before entering the pig stables and the overalls were to be washed daily.

Slaughter of the pigs took place within the compound only three meters from the outdoor pens. After stunning and bleeding the blood was collected in an approximately one meter deep hole where it was buried. The carcasses were washed with water from a pipe and the water was collected in the same hole as the blood. Hair from the slaughtered pigs were removed and left on the ground. The pigs were hanged on a wooden construction where evisceration and cutting was performed. Offals were buried with the blood and water and the

pork taken to the Rehabilitation Centre where it was stored in freezers. For staff engaged in the slaughtering process, overalls and gumboots were washed after slaughter.

Within the compound there was also an office/storage building, a smaller room for the guards at the gate and latrines. There was a pork joint (a simple restaurant serving pork) neighbouring Adina farm which also operated as a combined slaughter place. Offals from this neighbouring slaughter place were left in the open.

It had occurred on several occasions that pigs had escaped their pens and gained access to the rest of the compound. The pigs were not individually marked and they were moved around between different pens without any records being kept.

The outbreak

At the time of the outbreak there were 35 adult pigs and 103 piglets/growers on the farm. The outbreak started on March 7th 2014 with one boar falling ill with clinical signs including fever (40.8°C), lack of appetite, shivering and ataxia.

The farm was visited by Swedish and Ugandan veterinarians three times during the outbreak. They made several observations that indicated an inadequate understanding of biosecurity measures among the staff. Aborted material had, for example, been left in a pen, disinfection of boots was performed without prior cleaning of them and not all members of staff wore overalls. Slaughtering was done inside the compound close to the pig pens and pieces of meat were left around the slaughter slab. The slaughter slab's wooden construction could not be cleaned and interfered with cleaning of the ground and the slaughter slab was covered with pig hairs. Dead pigs were left lying outside awaiting burial which was done within the compound. Sick and healthy pigs were moved between pens and no records of pig movements were kept.

The capacity of the septic tank was insufficient resulting in septic water overflowing parts of the compound, see figure 6. Cleaning water from the inside pens was running along the outside of the outside pens. The flooring of the inside pens was very uneven which prevented

proper cleaning and disinfecting.

Figure 6, a-b *a) Adina farm indoor and outdoor pig stables b) Septic tank overflow (Photo: Erika Chenais).*

Dynamics of the outbreak

The outbreak started on 7th of March 2014 with one boar falling ill, the boar died the following day. Between 7th and 23rd March, 15 adult pigs and 24 young pigs died due to ASF. Another additional 11 adult pigs had been slaughtered and 3 young pigs had died from other causes. Between 23rd March and 2nd April, 4 adult pigs and 19 young pigs had died. Another additional 8 pigs had been slaughtered. The total number of dead pigs due to ASF up until 2nd April was 19 adult pigs and 43 young pigs. Another additional 19 adult pigs had been slaughtered. Eleven of 13 pens had pigs that died and/or were slaughtered due to ASF. For movements and deaths of pigs, see figure 7.

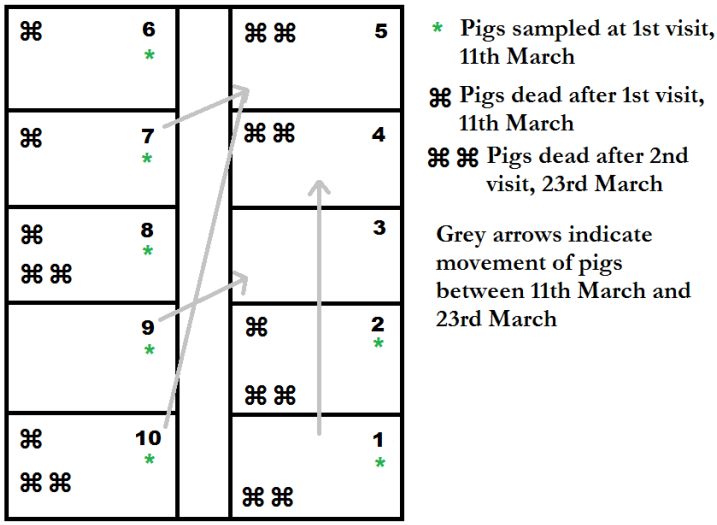


Figure 7 *Illustration showing indoor pig stables at Adina farm with deaths and movement of pigs (indicated by arrows) during the ASF outbreak indicated. Pens 5 and 6 are opposite the latrines and septic tank, pens 10 and 1 are by the entrance to the stables.*

After depopulation

The board of Adina Foundation decided to restart the piggery after the outbreak and to realise the vision of an agricultural training centre.

The last pig was slaughtered in the beginning of June 2014 whereupon the decontamination of the farm could commence. The outdoor area of the compound has been dug up and burned using papyrus and paraffin. The stables have been thoroughly cleaned and disinfected using BioSafe, a Virkon-based disinfectant. New cement floors have been put in and walls have been re-painted. The Foundation in presently negotiating with a neighbour regarding buying more land to facilitate the expansion. The neighbouring pork joint has gone out of business.

DISCUSSION

Biosecurity in the Gulu smallholder context

The results from the study do not provide any indication of causality of events, but only shows correlations of different factors.

In Gulu district the yearly incidence of ASF was estimated at 15%, based on the interviews, and the disease constitutes a constant and potent threat to pig production. When identifying the keeping of livestock as an important source of income as well as a pathway out of poverty, it is clear that ASF and other infectious animal diseases have a major impact on several levels. Of the 15 households that lost their herds to ASF, eight had not restarted their pig production at the time of the interviews. Lack of compensation after outbreaks of ASF obstructs for smallholder farmers to restart their pig production (Costard et al., 2009b; Sánchez-Vizcaíno et al., 2012; Crafoord, 2014). This problem is also identified in smallholder settings outside of Africa and in correlation to other infectious animal diseases (Nampanya et al., 2010).

The smallholders in Gulu who had recently been affected by ASF were less likely to believe that biosecurity could protect their pigs from ASF infection. It is possible that this opinion was held due to their recent loss and is an expression of feeling powerless in their situation. Another possibility is that they had a generally lower confidence in biosecurity and therefore had been less careful and as a consequence ASF had infected their pigs. On the other hand, there was no significant difference between groups recently and not recently affected in the willingness to invest in biosecurity, which indicates that smallholders regardless of whether they had lost pigs in ASF or not, had some level of trust in biosecurity.

Three households explicitly stated that their pigs had received vaccination against ASF. It is possible that the actual number is higher as several respondents stated that their pigs had received injections or prophylaxis, without clarifying further. Crafoord (2014) has also described the belief among smallholders that there is a vaccine available. Vaccination against ASF was how the smallholders perceived the treatment given to their pigs and it is possible that it was an antiparasitic or antibiotic substance. Nevertheless, if a smallholder believe that an ASF-vaccination occurred and the pigs die from ASF, a possible long-term effect is reduced confidence in veterinary services as well as paying for something useless. Another possibility is that smallholders in the belief that their pigs are vaccinated against ASF take unwanted risks which could introduce the disease to the herd.
The development of an effective vaccine is considered feasible (Costard et al., 2009b) but even if or when such a vaccine is developed, biosecurity will remain a necessity for successful pig production (Penrith & Vosloo, 2009).

Households that were recently affected by ASF were more likely than not recently affected households to approve of pork purchase from a slaughterhouse receiving pigs that had been in contact with ASF-infected pigs. Contact-pigs could be considered a risk factor, as it is possible that they are not yet showing clinical signs, and will be a possible source of infection as contaminated pork. Tejler (2012) found that at least 8 of 16 outbreaks of ASF in Gulu district 2010-2011 were probably introduced by contaminated pork, which further emphasises the importance of pork as a mean of ASF introduction, both in the Gulu context and elsewhere.
When looking at all households in this study, the general opinion is that households do not approve of this type of pork purchase, which supports the findings of Crafoord (2014), that the awareness of pork being a possible way of transmission for ASF was widespread among smallholders in Gulu district.

One third of the households included in the study had off-farm income and these households were more likely to have invested in biosecurity. It is likely that these households had more financial resources than households with only farm income which enabled them to make such investments. It should be noted that the mere purchase of gumboots or other equipment is not the solution for keeping the herd free from ASF or other infectious disease, but the investment should be regarded as an indicator of the household's attitude towards biosecurity. Financial resources is not the same as literacy and/or level of development, but these parameters are not entirely disconnected in smallholder settings. With this in mind the findings of this study are not corresponding with the findings of a Laotian study on smallholders' knowledge on biosecurity and diseases in large ruminants, where the province with the highest literacy rate and level of development had the lowest knowledge scores of all provinces in the study (Nampanya et al., 2010).

Households that kept pigs confined were equally affected by ASF as was households that practised other housing systems. This is in contrast with the findings of Penrith et al. (2013), were confinement of pigs reduced losses during ASF outbreaks. Many households in this study practised two different housing systems and any protecting effect by keeping pigs confined could have been lessened by free range pigs in the same household. Pig housing is a factor that vary depending on season (Chenais et al., 2015; Crafoord, 2014). It is possible that the findings in this study would be different if conducted at another time of the year or with a larger sample size, as it is difficult to get significant results with smaller sample groups.

The response rate was high in the interviews, which is positive for the reliability of the results. The interviews were conducted in Luo which was the main language of the respondents. As the interviewers spoke both Luo and English, confounding results due to language was minimised. It is however possible that certain smaller aspects were lost in the translation to English, but it is not considered to have been significant for the results. The questionnaire can be regarded as extensive, and as the respondents were asked about numerous details of the household's activities from the past six months, it is possible that some answers given were not correct. There were only two interviewers used, who had previously received training in interview techniques. Nevertheless, the personalities and skills of the interviewers can also have influenced the answers.

The challenges facing the Gulu smallholders are many, but it must be considered as promising that they generally have a high knowledge on ASF in combination with a high trust in biosecurity. These aspects could help improve their situation. A major constraint is, however, their economic situation, and the impact it has on their possibilities to change their traditional free range pig husbandry systems as well as investing in biosecurity equipment. The role of livestock is complex in these settings, and livestock has the potential to reduce poverty. Simultaneously, infectious animal diseases, such as ASF, have a severe impact and can further deepen the smallholders' poverty.

Biosecurity is indeed a basic condition to reduce infectious animal diseases and when implemented and followed it can consequently improve the livelihood for many.

The example of Adina farm

ASF constitutes a constant threat to pig production in endemic countries. Despite the high ambition of Adina farm, and the considerable investments made, ASF wiped out the entire herd. The staff have become aware of the importance of biosecurity and it is essential that it is kept in mind for the future that no matter how many measures are implemented or how strict they are, the key is to make sure that all members of staff as well as visitors oblige to the rules and respect the routines implemented.

Probable entry of disease

Finding the way of entry is made difficult by the fact that investigation and analysis is being done retrospectively. Furthermore, crucial information is lacking due to that Adina farm kept insufficient records. Information on natural services and visitor routines are missing and would be important pieces of information to add to the overall picture. It should also be noted that Lira District and the surrounding area around Adina farm can be regarded as containing several potential sources of ASF infection.

The boar that was the first sick and dead animal during the outbreak had escaped its pen and was running around within the compound six days before showing symptoms. Keeping in mind the pork joint and slaughter place that was neighbouring the farm, it is possible that infectious pork material had been thrown over the fence and was found and eaten by the boar, making the virus entry feed-borne. The boar was later returned to its pen where it could pass the infection horizontally to other animals. It is well known that contaminated pork is an important way of introducing ASF (Costard *et al*., 2009b; Penrith & Vosloo., 2009; Penrith *et al*., 2013; Tejler, 2012).

Adina farm had routines regarding protective clothing for the staff, but the routines were not followed. The possibility of indirect transmission, where a member of staff had ASF-contaminated material on shoes, clothing or equipment and later came in contact with the pigs, can not be ruled out. Indirect contact as a means of ASF transmission is not to be underestimated in this type of setting, as described by Costard *et al*. (2009b) and Sánchez-Vizcaíno *et al*. (2012).

Sabotage is another possible way of entry, that someone deliberately transmitted the infection, for example by feeding the pigs contaminated pork. This way of entry is however regarded as unlikely, Adina farm was at the time an employer to many people, as well as doing important work for underprivileged children. The results of transmitting ASF to the pigs at the farm was that several people became unemployed and the funding to the Rehabilitation Centre and their important work was cut off. The outbreak resulted in losses on several levels – animals lost, loss of revenue as well as job opportunities, and it is difficult to find any particular benefits from the outbreak.

Factors that facilitated the spread of the disease within the farm

Several factors were of importance for enabling the spread within the farm. Animals were being moved and staff moved between pens and between tending to sick and healthy animals without adequate preventive measures. Slaughtering of pigs occurred in close proximity to healthy pigs, with an obvious risk of transmitting virus from dead to live pigs. Fasina et al

(2012b) state that a high risk factor for contracting ASF on farm level is the presence of an abattoir in the area of pig farms.

Biosecurity measures after the outbreak

Several improvements of biosecurity need to be made to prevent future outbreaks and measures taken to remove viable virus that may still be within the compound. As Uganda is an endemic country for ASF, the threat of ASF remains present.

Below follows my biosecurity recommendations for Adina farm.

Clean and dirty zones should be established with barriers between. Example of barriers is one at the entry to the farm and at entry to stables. At these barriers, boots and overalls should be changed.

Trained staff that know and respect the routines should remain employed, high staff turnover should be avoided, which is also desirable according to Fasina *et al*. (2012a).

The capacity of the septic tank has been inadequate with consequences of septic water and material overflowing within the compound. This problem could be solved by a bigger tank, or by having the tank emptied more frequently. When emptying the tank, it must be ensured that adaption between the tank, the pipes and the lorry is tight to prevent leaking of septic material. As the location of the septic tank is far from the road, a lorry emptying it must enter the compound. This demands the adequate cleaning of the lorry prior to entering the compound. The septic material emptied from the tank must also be taken care of in an acceptable manner, to rule out transmission of pathogens from the septic material.

Slaughter should be performed outside of the compound (not in the clean zone). Preferably, a slaughter slab should be fenced to ensure that unauthorised people do not have access to it. The slaughter slab used must be constructed on a cemented area or equivalent to ensure satisfactory cleaning after slaughter. Slaughtering should be performed using staff and equipment that is only used for this purpose. Staff re-entering the compound after slaughtering should clean themselves and equipment used in slaughter before entering the compound. Staff working with slaughter should not attend the pigs. Remnants of pigs (skin, head, bones) must, if they are not sold, be buried deep like blood and offals. Kabuuka *et al*. (2014) describe the lack of well-established slaughter systems as a potent way of spreading ASF in Uganda.

Keeping of books is essential to keep track of the pig herd, their whereabouts, diseases, deaths and births. This is described as an on-farm biosecurity measure by Kabuuka *et al*. (2014). It would also be helpful to have pigs individually marked. Movement of pigs between pens should be kept to a minimum. Pigs escaping and later returned to their pens is not acceptable, measures to ensure that pigs do not escape need to be implemented. If pigs still escape, they should be quarantined and not instantly returned to the rest of the herd.

In accordance with the decision of the board of Adina Foundation, Adina farm will also hold an agricultural training site within the compound that houses the piggery. This type of dual purpose compound highlights the importance of biosecurity, and means that biosecurity

measures implemented also need to be understood and respected by visitors involved in the agricultural training.

During the outbreak at Adina farm, the staff used disinfectants on their boots without prior cleaning. As organic material makes disinfectant foot baths ineffective, it is possible that the procedure performed during the outbreak gave the staff a sense of false security.
In a review article on biosecurity for backyard poultry, it is concluded that many farmers in low-income countries lack knowledge of how to properly use disinfectants to protect their animals (Conan *et al*., 2012).

The outbreak at Adina farm is a good example of the challenges facing pig producers in ASF endemic areas as well as showing that ASF is a heavy burden for many, and on several levels. Adina farm has experienced the importance of biosecurity and the possible impacts when biosecurity is lacking. Despite this, they see a way forward and have identified pig production as a lucrative business to further strengthen their welfare and important work. Improvements in their biosecurity will empower their farm, and hopefully ensure the funding to their important work in the community in a long-term perspective.

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APPENDIX

1. Questionnaire ID

_____

2. Date of Survey

- ❑ 2014-09-17
- ❑ 2014-09-18
- ❑ 2014-09-19
- ❑ 2014-09-20
- ❑ 2014-09-21
- ❑ 2014-09-22
- ❑ 2014-09-23
- ❑ 2014-09-24
- ❑ 2014-09-25
- ❑ 2014-09-26
- ❑ 2014-09-27
- ❑ 2014-09-28
- ❑ 2014-09-29
- ❑ 2014-09-30
- ❑ 2014-10-01
- ❑ 2014-10-02
- ❑ 2014-10-03
- ❑ 2014-10-04
- ❑ 2014-10-05
- ❑ 2014-10-06

- ❑ 2014-10-07
- ❑ 2014-10-08
- ❑ 2014-10-09

3. You participated in a previous part of this project by answering many questions about you and your pigs. According to you, how many months has passed since we here last time?

- ❑ 1
- ❑ 2
- ❑ 3
- ❑ 4
- ❑ 5
- ❑ 6
- ❑ 7
- ❑ 8
- ❑ 9
- ❑ 10
- ❑ 11
- ❑ 12

4. Enumerator

- ❑ Alike Solomon
- ❑ Bruce Nokorach
- ❑ Peter Ogweng

5. Time interview started

_____

6. Time intreview ended

_____

7. Name of the head of the household

_____

8. Respondents name

_____

9. Respondents telephone number

_____

10. Gender of respondent

- ❑ Male
- ❑ Female

11. Marital status of household head

- ❑ Married
- ❑ Widow/widower
- ❑ Single parent
- ❑ Other (specify)

If other, specify:

_____

12. Subcounty

- ❑ Awach
- ❑ Bardege
- ❑ Bobi
- ❑ Bungatira
- ❑ Koro
- ❑ Lakwana
- ❑ Lalogi
- ❑ Odek
- ❑ Ongako
- ❑ Paicho
- ❑ Palaro
- ❑ Patiko
- ❑ Unyama

13. Parish

- ❑ Acoyo
- ❑ Abwoch
- ❑ Agonga
- ❑ Alokolum
- ❑ Angaya
- ❑ Atiabar
- ❑ Bardege
- ❑ Binya
- ❑ Forgod
- ❑ Gem

- ❑ Gweng Diya
- ❑ Ibakara
- ❑ Idobo
- ❑ Kal
- ❑ Kal-ali
- ❑ Kalumu
- ❑ Kanyagoga
- ❑ Kasubi
- ❑ Labworomor
- ❑ Laliya
- ❑ Lamola
- ❑ Lapinat west
- ❑ Laroo
- ❑ Lujorogole
- ❑ Lukwir
- ❑ Mede
- ❑ Otino
- ❑ Pabwo
- ❑ Paduny
- ❑ Paidwe
- ❑ Pakwelo
- ❑ Palenga
- ❑ Parwech
- ❑ Patuda
- ❑ Pawel
- ❑ Pugwinyi
- ❑ Pukony
- ❑ Te-got

14. Village

_____

15. GPS coordinates Latitdues N/S

_____

16. GPS coordinates Longitudes E/W

_____

17. Household details: Did anyone leave or enter the household since last visist?

Compare with list from last visit

- ❑ Yes
- ❑ No

Specify if entry or exit, if entry provide details in question below, if exit specify whom. Compare to list from last visit.

18. Household details

Gender: 1=Male, 2=Female

Relationship to household head:

1 = Head, 2 = Spouse , 3 = Child, 4 = Sibling, 5 = Parent,

6 = Grandchild, 7 = Other relative, 8 = Non-relative (including employees who live in house), 9 = Other (specify in comments)

Highest education level:

0 = No formal education, 1 = Nursery, 2 = Pre-school age,

3 = Primary education (P1-P4),

4 = Primary education (P5-P7), 5 = Secondary school (S1-S2),

6 = Secondary school (S3-S4),

7 = High school (S5-S6), 8 = Vocational training (specify no of years in comments), 9 = Tertiary training (specify no of years in comments), 10 = University degree (undergraduate)

11 = University degree (postgraduate), 12=Adult literacy, 13=Other (specify in comments)

Primary source of income:

0 = None, 1 = Crop farming, 2 = Pig keeping (incl. sales) , 3 = Cattle keeping, 4 = Poultry/keeping (inc. sales), 5 = Salaried employment, 6 = Self-employed-off farm, 7 = Casual laborer, 8 = Boda boda,

9 = Student/pupil, 10 = Charcoal burning, 11 = Pre-school age,

12 = Other (specify in comments)

	Members of household [*FIRST NAMES]*	**Year of birth**	**Gender**	**Relationship to household head**	**Highest education level attained**	**Primary source of income**

1						
2						
3						
4						

Comments

20. Chidren of school age:

Type of school:

1=Public (UPE/USE) day school, 2=Private day school, 3= Private boarding school, 4= Religious day school,

5= Religious boarding school, 6=Other (specify in comments)

Reason for missed school days:

1=School closed, 2=Child sick, 3=Child needed at home (work, other), 4= Could not pay school fees or material, 5=Other (specify in comments)

	Name	Type of school	Cost per term	Number of missed schooldays during last term	Reason for missed schooldays
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					

14					
15					

Comments

22. Does the household have off-farm income?

- ❑ Yes
- ❑ No

23. Is the household engaged in the following pig related activities

- ❑ Pig trading
- ❑ Processing of pork/pork products (e.g. slaughter)
- ❑ Operating a butchery
- ❑ Operating a pork kiosk
- ❑ Operating a pork joint
- ❑ Other

If other, specify

_____

24. Indicate the type and number of livestock kept/owned currently

Pigs _____

Cattle _____

Sheep _____

Goats _____

Poultry _____

Other _____

25. Indicate the different categories of pigs kept currently:

Breed type: 1=Local, 2=Cross, 3=Exotic

Housing: 1=Confined, 2=Tethered, 3=Free range

	Numbers kept	Breed type	Housing
Breeding boars	_____	_____	_____
Breeding sows	_____	_____	_____
Growers	_____	_____	_____
Piglets	_____	_____	_____

26. Have any pigs left your herd since the last visit?

- ❑ Yes
- ❑ No

27. Pig exits

Breed: 1=Local, 2=Cross, 3=Exotic

How exited: 1=Sold, 2=Sold because sick, 3=Sold because fear of pig disease, 4=Slaughter for sale,

5= Slaughter for household consumption, 6=Slaughter because sick, 7=Stolen, 8=Death, 9=Gift, 10=Other (specify in comments)

In case of death, cause: 1=Disease, 2=Starvation, 3=Poisoned, 4=Injury, 5=Other (specify in comments)

	Breed	How exited	How many pigs exited	How many pigs died	In case of death; cause	If disease; which
Breeding boars						
Breeding boars						
Breeding boars						
Breeding sows						
Breeding sows						
Breeding sows						
Growers						
Growers						
Growers						
Piglets						
Piglets						
Piglets						

28. Comments

29. Has there been any inflow of pigs through purchases, births or

any other form since the last visit?

- ❑ Yes
- ❑ No

30. Pig entries

Breed: 1=Local, 2=Cross, 3=Exotic

Type of entry: 1=Bought from smallholder farm, 2=Bought from individual trader/broker, 3=Bought from a large scale farm, 4=Loan from project, 5=Gift, 6=Birth/born on farm, 7=Other (specify in comments)

Reason for purchase: 1=Replace old stock, 2=Saving money, 3=Prestige, 4=Expand herd, 5=Other (specify in commetns)

Purchase point: 1=Within village, 2=Neighbouring village, 3=Other (specify in comments)

	Breed	Type of entry	How many pigs	Reason for purchase	Cost per animal	Purchase point
Breeding boars						
Breeding boars						
Breeding boars						
Breeding sows						
Breeding sows						
Breeding sows						
Growers						
Growers						
Growers						
Piglets						
Piglets						
Piglets						

31. Comments

_____

_____

_____

_____

32. Have you done any expansion in the pig enterprise since last visit?

- ❑ Yes
- ❑ No

33. If yes, specify how:

_____

_____

34. Do you keep records associated with the pig enterprise?

- ❑ Yes
- ❑ No

35. What types of records?

- ❑ Feeds
- ❑ Reproduction and breeding
- ❑ Animal inventory (births, deaths, sales)
- ❑ Financial (income and expenditure)
- ❑ Other

If other, specify

_____

36. Did you sell any pigs since the last visit?

- ❑ Yes
- ❑ No

37. Indicate the numbers sold from each pig category:

Sales outlet: 1=Farm gate, 2=Village/local market. 3=Slaughterhouse/abbatoir, 4=Butchery, 5=Other (specify in coments)

	How many sold	Weight (live)	Weight (carcass)	Price/head (UGX)	Sales outlet
Breeding boars					
Breeding sows					
Growers					
Piglets					

38. Comments

_____

_____

_____

_____

39. Did you have any other income related to products from your own pigs since the last visit?

- ❑ Yes
- ❑ No

40. If yes, what was the total income since the last visit?

_____

41. Do you own a breeding boar?

(If no skip to Q 44)

- ❑ Yes
- ❑ No

42. Do you use it/them for own or communal breeding?

- ❑ Own
- ❑ Village/communal
- ❑ Other

If other, specify:

_____

43. How much do you charge per service (UGX)?

_____

44. What was your total income from the breeding boar since the last visit?

_____

45. Indicate the source of breeding for the sows since the last visit

- ❑ Didnt do any breeding
- ❑ Own boar

- ❑ Other boar

If other, specify:

_____

46. What is the cost per service (UGX or other)?

_____

47. What was your total expenditure for the breeding service since the last visit?

_____

48. Did you have any hired labour engaged in the pig enterprise since the last visit?

- ❑ Yes
- ❑ No

49. If yes, what was your total expenditure for hired labour engaged in the pig enterprise since the last visit (UGX)?

_____

50. Did your pigs recieve any medical treatments (deworming, antiparasitic, profylaxis, antibiotics, vaccination) since the last visit?

- ❑ Yes
- ❑ No

51. If yes, what treatment(s)?

_____

_____

52. What was your total expenditure for medical treatments since the last visit (UGX)?

_____

53. Did you have any expenditure for biosecurity eqipment (protective clothing, boots, disinfectants etc) since the last visit?

- ❑ Yes
- ❑ No

54. If yes, what sort fo equipment did you buy?

_____

_____

55. What was your total expenditure for bio security eqipment since the last visit (UGX)?

_____

56. Did you receive any extension service related to pigs since the last visit?

- ❑ Yes
- ❑ No

57. What was your total expenditure for extension service related to pigs since the last visit (UGX)?

_____

58. What was your total expenditure on pig feeds since the last visit (UGX)?

_____

59. Since the last visit, did you have to sell any household assets due to losses incured in the pig production?

- ❑ Yes
- ❑ No

60. If yes, Indicate what asset and the price obtained

	Type of asset	Price obtained
Asset	_____	_____
Asset	_____	_____
Asset	_____	_____

61. Since the last visit, how many times a week did your family eat meat (on average)?

_____

62. Have you needed any financial credit since the last visit)?

- ❑ Yes
- ❑ No

63. If yes, did you get the credit?

- ❑ Yes
- ❑ No

64. If no, why was credit not acquired?

- ❑ No collateral
- ❑ Credit terms unfavourable
- ❑ Other

If other, specify:

_____

65. Amonut needed, recieved, interest rate and use of credit

Reasons: 1=Family health problems, 2=Animal health problems, 3=Crop failure, 4=Investments, 5=Pay school fees, 6=Wedding, 7=Funeral, 8= Other, spcify in comments

Use of credit: 1=Feeds, 2=Animal health, 3=Labour, 4=Capital costs, 5=Other (specify in comments)

	Reason for needing credit	Amount needed	Amount received	Interest rate	Use of credit
Credit 1					
Credit 2					
Credit 3					

66. Comments

_____

_____

67. Since the last visit; 67. Since the last visit;

	No, none	Most not	Some yes, some not	Yes, most	Yes, all
Have the family been able to pay all needed school fees?					
Have the family been able to meet all medical expenses that has come up					
Have there been any family gatherings (weddings, funeral, baptisms) etc that had to be changed or postponed due to lack of money?					

Comments

_____

_____

68. Since the last visit;

	No, never	Most of the times not	Sometimes yes, sometimes not	Yes, most of the time	Yes, always
I feel more optimistic about the pig enterprise					
There has been an increase in disputes, disagreements or jealousy among my neighbours					
I have lost confidence in pig production					
I am no longer participating					

in the social networks like I used to do					

Comments

_____

_____

69. How do you agree with the following statements;

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I think it is possible to protect my pigs from getting ASF by improving farm bio security					
Eating pork from pigs that have died from ASF is safe for human health					
If I would get a fair price I would be willing to sell all my heatlhy pigs when an ASF-outbreak were present in the area					
I would like to invest in farm bio security if I recieved advice on what to do					
I would be happy to buy pork products from a slaughterhouse that recieve pigs that have been in contact with pigs dying from ASF					
It is safe to give pigs water that has been used to clean knifes and pangas used for slasughtering and butchering as drinking water					
Buying live pigs is a risk behaviour for contracting ASF					
I dont want to eat or buy pork from pigs that have died from ASF					
I can not afford to invest in my pig farming					
ASF can not be prevented					
I can choose where/to whom I sell my pigs					
Frequent sellling and buying of pigs is					

neccessary for succesfull pig farming					
Improved farm bio security improves pig health and pig growth					
I could adopt my pig farming in order to have pigs ready for sale at specific times of the year					
Cooking kills the ASF-virus					
It is possible for me to tell visitors such as veterinarians, middle men and extension workers not to enter in the pig house with their own boots					
If pork prices are lower in the neighbouring village due to them having an outbreak of ASF I will buy my pork there					

Comments

_____

_____

70. Comments

_____

_____

_____

_____

Questionnaire used in study one.